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THE CONTROL OF EUROPEAN FOULBROOD

E. F. PHILLIPS
Apiculturist

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L. O. HOWARD, Chief

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EUROPEAN FOULBROOD is a disease of the brood of bees which has caused great losses to American beekeepers. It was first recognized as a distinct disease in the United States by New York beekeepers in 1894, but it has probably been present in the United States for a long time.

It is important that the beekeeper know whether European or American foulbrood is in his apiary, for the two do not respond to the same treatment. In European foulbrood control the most important step is to prevent the entrance of the disease by keeping all colonies strong and by having all stock resistant to the disease. This can be done successfully even though the disease is in the neighborhood.

In case, through failure to take all precautions, the disease does enter, there are certain practices by which the disease can be readily eliminated, but all of these must be used with care.

The facts about the disease on which the preventive and remedial measures are based are discussed in this bulletin.

THE CONTROL OF EUROPEAN FOULBROOD.

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DIFFICULTIES OF CONTROL.

EUROPEAN FOULBROOD has caused much trouble in treatment and causes more anxiety among beekeepers than does American foulbrood. It is recognized generally that European foulbrood requires less drastic methods than does American foulbrood, but seemingly one cannot always be so sure of the efficacy of the treatment, and it is often said by beekeepers that European foulbrood "does not fight fair." The difficulty seems to lie in the fact that the course of the disease in the colony has not been sufficiently studied and the features of treatment have not been adequately analyzed. It is not enough simply to know the name of the organism which causes the disease, but it is essential to know the habits of the germ in the colony.

European foulbrood was first recognized in New York State in 1894, and previous to that time no adequate differentiation had been made between this disease and American foulbrood. Various writers, especially those in Europe, had recorded two types of brood diseases and had differentiated them sufficiently to call one mild and the other virulent. Careful observations of beekeepers, as well as bacteriological investigations, have shown that the two diseases are entirely distinct, that one does not change to the other, and that in treatment they behave differently.

Now that the symptoms of the two diseases have been carefully studied, one can examine the earlier literature and find indications that European foulbrood was rather widespread in the United States before it was recognized as a distinct disease. At any rate it appears certain that all the European foulbrood in the country did not spread from the first recognized outbreak in New York State. New York beekeepers with justice objected to the name "New York bee disease" which was at one time applied to the disease.

NAME OF THE DISEASE.

When American beekeepers first differentiated this disease the name "black brood" was generally applied to it. When the investi-

gation of bee-disease control was inaugurated by the Bureau of Entomology it was recognized that this name was not well chosen, for black is not the predominating color of the dead larvæ. If any color designation were to be used, yellow would be best, but color is not a safe guide, as this is a variable symptom. Any descriptive name seemed unsafe for a disease with such variable manifestations, and the author therefore proposed that the name be changed. After consultation with beekeepers and apiary inspectors it was decided to adopt the name European foulbrood. This was first used in a circular[1] of the Bureau of Entomology and the name has been generally accepted by beekeepers throughout the country. The adjective "European" was chosen because it appeared that this disease had first been subjected to bacteriological investigation by European investigators, while the other disease, American foulbrood, had not been investigated carefully until such work was undertaken in America. The names obviously are not intended to convey the idea that the diseases originated one in America and the other in Europe, for the honeybee is not native to America. The names were chosen simply that beekeepers might have names which could be used with safety, and which would not lead to confusion by being descriptive.

SYMPTOMS.

The beekeeper should know whether he has to deal with American or European foulbrood, for they do not respond to the same treatment. The symptoms of European foulbrood are simply the outward manifestations of the disease, being chiefly the appearance of the larvæ after death. The symptoms are therefore variable. The most accurate method of diagnosis is by bacteriological examination, but this is, of course, not possible in apiary practice. In cases of doubt samples should be sent to the Bureau of Entomology for diagnosis.[2]

In regions where both diseases occur, beekeepers at times experience difficulty in differentiating them, due chiefly to insufficient observation of the symptoms. If European foulbrood appears in an apiary in the spring, and if American foulbrood is then observed later, the beekeeper may erroneously conclude that both types are

[1] Phillips, E. F. The brood diseases of bees. U. S. Dept. Agr. Bur. Ent. Circ. 79. 5 p. 1906.

[2] If dead brood is observed and the beekeeper is not able to diagnose it with accuracy, samples may be sent the Bureau of Entomology for examination. A piece of comb containing dead larvæ about 4 by 5 inches should be cut out and mailed in a heavy pasteboard or wooden box. Tin boxes should never be used, as the brood usually molds in transit, making examination impossible. The sample should not be wrapped before being placed in the box. A suitable box for sending samples will be mailed on request.

It is not possible to diagnose from empty combs, and no honey should be included in the sample, as it is valueless in diagnosis and will probably spoil the sample as well as other mail matter. The name of the sender must always appear on the package, and any available data should be sent in a letter. Never inclose a letter in the box with the sample.

manifestations of one disease, or that European foulbrood changes to American foulbrood. Such is not the case. It is therefore essential that the symptoms be studied with great care, since to treat American foulbrood by methods applicable only to European foulbrood will result in the spread rather than in the eradication of the disease.

(1) *Age of larvæ affectea.*—European foulbrood usually attacks the larva at an early stage of its development, while it is still curled up at the base of the cell (fig. 1, R). At the time of the first manifestation of disease the larva is about three days old, from the hatching of the egg. A very small percentage of larvæ die after

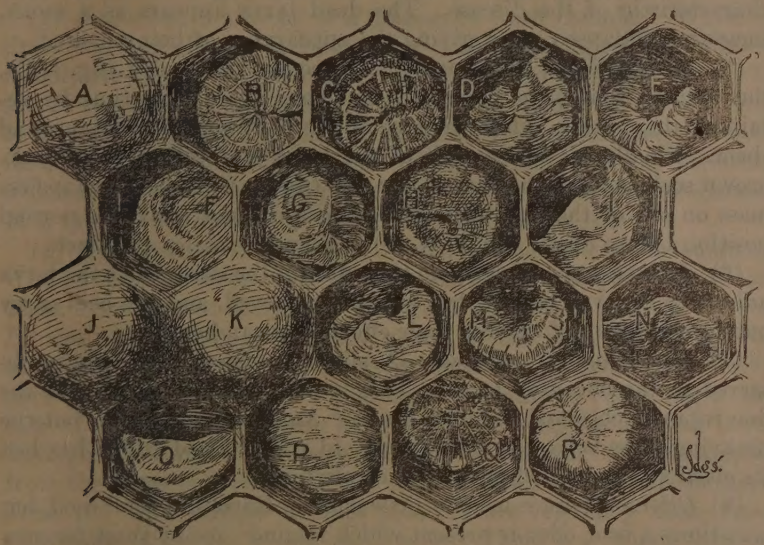

FIG. 1.—Portion of comb, showing effect of European foulbrood upon the larvæ: *A, J, K,* normal sealed cells; *B, C, D, E, G, I, L, M, P, Q,* larvæ affected by disease; *R,* normal larva at age attacked by disease; *F, H, N, O,* dried-down larvæ or scales.

capping, but sometimes quite young larvæ are attacked (fig. 1, E, M). Sunken and perforated cappings, which are such common symptoms of American foulbrood, are sometimes seen in colonies suffering with European foulbrood.

(2) *Early symptoms.*—The earliest indications of the disease are a slight yellow or gray discoloration and the uneasy movement of the larva in the cell. The larva loses its well-rounded, opaque appearance and becomes slightly translucent, so that the tracheæ may become prominent (fig. 1, B), giving the larva a clearly segmented appearance.

(3) *Position of larvæ.*—The larva may be flattened against the base of the cell, may turn so that the two ends are to the rear of the cell (fig. 1, P), or may fall away from the base (fig. 1, E, G, L). The

position of the larva is one of the best means of differentiating American foulbrood and European foulbrood. In American foulbrood the larvæ almost without exception are found on the lower side wall, while in European foulbrood they may be there, or at the base of the cell, or on any of the side walls, even the upper one.

(4) *Color.*—As the decay proceeds the color changes to a decided yellow or gray and the translucency is lost (fig. 1, Q, H). When the disease first appears in a region the yellow color of the decaying larvæ seems more constant than later, due probably to the fact that as the disease spreads the germ causing the disease is accompanied by other organisms. The yellow color may be taken as the chief characteristic of the disease. The dead larva appears as a moist, somewhat collapsed mass, giving the appearance of being melted.

(5) *Scale.*—When the remains have become almost dry (fig. 1, C), the tracheæ sometimes become conspicuous again, this time by retaining their shape, while the rest of the body content dries around them. Finally all that is left of the larva is a yellow or grayish-brown scale against the base of the cell (fig. 1, F, H), or a shapeless mass on one of the side walls if the larva did not retain its normal position before death (fig. 1, N, O). Very few scales are black.

(6) *Adhesion to cell.*—At no time during the decay does the larva adhere to the wax closely, but is easily removed, and the bees carry out a great many of them in their efforts to clean house.

(7) *Usual lack of ropiness.*—A slight ropiness is sometimes observed in the decaying larvæ. This is not, however, at all like the fine ropiness observed in larvæ dead of American foulbrood, but the decaying mass behaves more like an old rubber band which has lost its elasticity and which breaks when stretched.

(8) *Odor.*—There is usually little odor in European foulbrood, but sometimes a sour odor is present which reminds one of yeast fermentation. This odor is quite constant in some regions and seems to come from the decay due to organisms other than the one which causes European foulbrood.

(9) *Sex.*—A symptom of the greatest importance is the fact that the disease attacks drone and queen larvæ[1] nearly as quickly as those of the workers.

(10) *Epidemic character.*—In regions where the disease occurs a considerably larger percentage of colonies is affected than is usual for American foulbrood. However, not many colonies die of European foulbrood, but the chief trouble is that weakened colonies succumb during winter unless well cared for. The disease spreads at

[1] The tendency of this disease to attack queen larvæ is a serious drawback in treatment. Frequently the bees of a diseased colony attempt to supersede their queen, but the larvæ in the queen cells often die, leaving the colony hopelessly queenless. The colony is thus depleted rapidly.

times with startling rapidity, much more rapidly than American foulbrood.

(11) *Variability.*—In all its symptoms European foulbrood is more variable than is American foulbrood. Color is perhaps the most constant symptom.

BASIS OF TREATMENT.

The confusion in the treatment of the disease is due to a failure to analyze the factors forming the basis of treatment. Various treatments have been described in the beekeeping journals as distinct when they were simply modifications of the same treatment.

(1) European foulbrood is a disease of weak colonies. While at times one may observe larvæ dead of this disease in strong colonies, usually they are removed before the disease can do much harm. It should be pointed out, further, that it is the colony which is failing to increase in strength in the spring which is most seriously affected, for a small colony which is rich in young and vigorous bees and which is increasing in strength is often able to overcome the disease. It is therefore a disease of weak rather than small colonies.

(2) The disease is prevalent in the spring and early summer. While at times it is observed at other periods of the year, this is not usual. Samples of European foulbrood have been received by the Bureau of Entomology in every month of the year, but, as will be seen from Table I, they are far more commonly received in the early part of the active season. These samples are listed according to the date of receipt at the bureau laboratory. The highest number is received in June and the average date for the removal of these samples from the hives is probably a few days previous to June 15, perhaps June 10. The earliest samples received are regularly those from California, where the season opens early. There is a sudden increase in May and June and almost as rapid a decline later. The few samples received from October to April may be largely disregarded, as they are almost without exception dried material of unknown age.

TABLE I.—*Distribution of European foulbrood by months, including all positively diagnosed samples received by the Bureau of Entomology from 1906 to December, 1917.*

Month.	Total number.	California.	New York.
January	3	0	0
February	4	3	0
March	17	10	0
April	33	17	2
May	180	24	23
June	334	30	50
July	240	20	41
August	164	9	20
September	98	8	8
October	17	1	3
November	7	3	1
December	2	1	0

(3) The disease disappears later in the summer unless the colony has become so badly weakened that it can not remove the dead larvæ. Such weakened colonies usually die in winter or in a time of dearth. Colonies do not as a rule die as a direct result of European foulbrood. There may still remain some dead larvæ in the combs, showing that the bees have not been able to remove all of them, but in any but the worst cases even these disappear. If conditions which commonly prevail in early summer again appear there may be a recurrence of the disease the same season.

(4) This disappearance of the disease usually accompanies the beginning of the honey flow. At this time, unless the colony has already reached maximum strength, there is a rapid increase in brood rearing and the colony increases in strength, bringing about conditions unfavorable for the development of the disease. If the honey flow fails, the disease may continue and under such conditions is at its worst. It should be noted that in regions where the early honey flows are uncertain or usually lacking European foulbrood has done the most damage, for in years of failure the disease spreads with such rapidity that the entire region becomes badly infected. European foulbrood is rarely observed in regions where an early honey flow is certain.

(5) The earliest brood of the year usually escapes with little loss. This important fact has been overlooked in previous discussions of this disease, but it is evident from Table I. The scarcity of European foulbrood in the early spring was mentioned in the earliest accounts of its prevalence in New York. This in all probability is due to the fact that the colonies have been able to remove most of the disease during the previous summer and there has been left only a little of the infecting material.

(6) Some bees resist the disease more successfully than others. It has been found through the experience of beekeepers generally that the three-banded Italian bees are best for this purpose. These bees have a further advantage in that they give excellent results in all lines of beekeeping activity, and it is therefore safe to recommend them as the best. This does not at all indicate that other races of bees would not give as good results, as far as European foulbrood control is concerned, but that it is easier to get good three-banded Italian than good bees of any other race. The resistance appears to be either a form of immunity or a greater ability to remove the dead larvæ completely.

(7) European foulbrood is an infectious disease. This was clearly shown by the experience of beekeepers before the disease was investigated from a bacteriological standpoint, and these investigations have supported the observations of the beekeeper. The bacteriological

work has shown, further, that the disease is caused by an organism[1] which has never been found in any other brood disease of bees. The cause of the disease is, therefore, a specific organism, and the disease is entirely distinct from American foulbrood. This is an important point, for there has in the past been considerable confusion in that a few beekeepers have claimed that one disease changes to the other. It should be made clear that this supposition is not supported by any careful observation in the apiary, and that it was recognized generally by beekeepers before the bacteriological investigations were made that the diseases were distinct.

(8) The organism causing European foulbrood does not seem from observations in the apiary to be so difficult to eradicate as does the one causing American foulbrood. This is partially confirmed by the bacteriological observations also.

(9) When a bee larva dies of European foulbrood the decaying mass does not adhere closely to the cell wall at any time in the decay or when it has dried down to a scale in the back or on the side walls of the cell. Dead larvæ may therefore be removed easily by the bees if conditions are favorable for this cleaning.

(10) The bees are able under suitable conditions of colony strength and resistance to clean the cells so thoroughly that when future larvæ are reared in these cells the disease is not contracted.

(11) The method of spread of the disease is not well known, although there is some evidence that the infection is carried chiefly by nurse bees. It has been observed that under some circurstances it may be transmitted through feeding, but the experience of beekeepers indicates that contaminated honey is not the common means of carrying the disease. It is well known that honey from infected colonies may be given to healthy colonies with entire safety provided the healthy colonies are in such condition that they are able to resist the disease. It is therefore not necessary to disinfect the honey from colonies having European foulbrood, as is the case with that from colonies suffering from American foulbrood.

(12) It has not been found necessary to disinfect hives, combs, or frames from diseased colonies. This does not indicate that the germ causing the disease is absent from such material, but that if present it does not do any damage.

(13) While the disease spreads with great rapidity at times, it does not seem to be so malignant as is American foulbrood, since many colonies exposed to infection fail to contract the disease.

These facts concerning the disease have been discovered in the apiary rather than in the laboratory. The facts are supported by repeated observations, and while the records of observation are not as accurately made as are those of the laboratory the correctness of most

[1] *Bacillus pluton.*

of the facts is attested by the experience of hundreds of beekeepers. In certain cases the findings have been corroborated by bacteriological investigation.[1] The methods of treatment have also all been devised in the apiary.

The difficulty in drawing conclusions from practical observations is that too often beekeepers fail to show the ways in which their experience differs from that of others or in what manner the same principles have been applied in a slightly different manner.

PREVENTIVE MEASURES.

In keeping European foulbrood under control it is far more important to prevent the disease from getting a foothold in a colony than it is to eradicate the disease afterward.

This is not true of American foulbrood, for reliable and practicable preventive measures have not been found for that disease.

(1) The use of resistant stock is of the greatest importance, otherwise there is no hope of warding off the disease when it enters a region or of eradicating it from the apiary after it is once introduced. The use of strong, vigorous Italian stock is best from the standpoint of honey-production, and every beekeeper should therefore see that his apiary is provided with such queens even before European foulbrood appears in the immediate neighborhood or in the apiary. When the disease is absent it is quite permissible for the beekeeper to save any mismated queens which show themselves to be good, but when European foulbrood is near by this course is unsafe, and in no case should a mismated queen be used as breeding stock. The purity of mating of queens then becomes a matter of first importance and this entails more work than is necessary in the ordinary practices of the apiary.

It is not enough simply that queens be pure bred and purely mated, however, for it often occurs that a queen will be poor from other causes. Whenever a queen shows signs of failing it is good beekeeping to replace her with a good queen. When European foulbrood is present this becomes far more important.

Not all Italian stock is equally resistant to European foulbrood, and when the disease is nearby it becomes important that the beekeeper find out which stock is best. Not all queens sold as Italians are pure bred. By far the best plan is to buy a few untested Italian queens from each of several queen breeders and after these have been under observation for a short time the beekeeper will be able to choose from the lot those best suited for breeding purposes. It is not so good a practice to buy a breeding queen, for such queens do not ship

[1] Bacteriological studies have been useful in practical beekeeping in analyzing observations, serving to guide the observations of beekeepers in correct lines. They have been especially important in devising methods of laboratory diagnosis, so that it is possible to obtain definite knowledge of the presence of disease.

so well in the mails, and even a breeding queen of the most resistant stock might allow her colony to become infected simply because she had been so injured in the mails that she could not keep up egg-laying properly. The buying of untested queens is to be advised at all times, for until more accurate work in breeding is done the individual beekeeper can choose breeding stock as well as most breeders.

It would be possible to recommend certain stock as the best were it not for the fact that the stock of the various queen breeders is not constant. The stock which in one year makes the best showing possibly can not be duplicated by the queen breeders the next year. The best course therefore is for each beekeeper, or possibly a group of beekeepers, to try out several strains of Italian bees to find which is best. Having done this, they can continue to breed from the best stock obtained, and they can do as well by that means as they can if they continue to buy queens from the queen breeders.

(2) Strength of colony is fully as important as resistant stock. Unfortunately too many beekeepers fail to provide conditions necessary to the bees in order that the colonies may be at the proper strength in time to combat European foulbrood successfully. It is good beekeeping to have all colonies strong, and nothing leads to large honey crops as does this factor, yet throughout the country there are thousands of beekeepers who annually fail to get half the crop through failure to have strong colonies at the right time. When the honey-flow comes early in the season, as is the case throughout most of the United States, it is important that every colony be at maximum strength early in the spring. Since European foulbrood appears in the spring and early summer, good beekeeping practice again coincides with the requirements for preventing the ravages of this disease.

One difficulty arises from the fact that there is no standard for strength of colony and what one beekeeper considers a strong colony may be considered weak by another and better beekeeper. At the opening of the honey-flow every colony from which a full crop is to be expected should be strong enough to have 10 full combs of Langstroth size filled with brood. Of course this brood may be in a larger number of combs, since the bees usually store some honey at the top of each comb, but it is easy to estimate the brood in terms of full combs. If now we accept the same standard for the desired strength of colony for the purpose of resisting European foulbrood, we will have a condition under which (assuming resistant stock) this disease will never get a start in any colony in the apiary. It is of course recognized that such a standard is seldom realized before or at the beginning of the honey-flow, and this fact is the reason for the loss of so much honey as well as the full explanation of the ravages of European foulbrood in so many places. It is suggested that each beekeeper in a region where European foulbrood exists ask

himself whether his colonies are actually in as good condition at the opening of the year as he has supposed and that he find out how strong the colonies may be made by providing the best of conditions for the development of the colony population. A beekeeper whose colonies do not measure up to this standard should not condemn the standard until he assures himself that it is entirely impossible, under his conditions, to reach it.

Obviously the proper wintering of bees becomes a matter of the highest importance in regions where European foulbrood is found. Those who fail to practice good wintering are the ones who first lose so many colonies that they become discouraged and give up beekeeping, while those whose wintering has been better are able to treat the disease although their standard of colony strength may not be high enough entirely to ward it off.

As was pointed out earlier, the first brood of the year usually escapes with little loss. If proper conditions are provided for winter, either in the cellar or outdoors, brood-rearing is delayed, whereas in poor wintering brood-rearing may begin during the coldest period of the winter.[1] If then brood-rearing is delayed by protection, it will begin as a reaction to incoming nectar and pollen. The vitality of the bees has not been destroyed by unseasonable brood-rearing and the colony can rear large quantities of brood from the very beginning. This can, of course, occur only when the colony has proper spring protection. The earliest brood will emerge without appreciable loss from disease, the colony is increased in strength at once, and its capacity for brood-rearing is great. Provided the stock is resistant, the colony is then able to ward off the disease. To bring about all the proper conditions with the least labor on the part of the beekeeper and the least waste of effort on the part of the bees, it is desirable to winter outdoor colonies in two hive-bodies, which has been recommended by this department for other reasons also.

Good beekeeping, in so far as handling the bees is concerned, consists of providing conditions in the fall so that the colony is full of young, vigorous bees for winter; of providing conditions of protection and good stores such that the bees are not depleted in numbers and vitality during the winter by excessive heat-production; of providing plenty of stores, adequate room for breeding, and abundant protection during the period of heavy brood-rearing in spring; and of preventing reduction in the strength of the colony by swarming. All of these things, and there are no others of importance, pertain to keeping colonies strong. The beekeeper who provides conditions such that the bees can keep up their own strength will not only reap the honey-crop but he will escape the ravages of European foulbrood.

To a large degree the failure of American beekeepers to get their colonies strong enough is due to the use of small hives that are in-

[1] The explanation is given in the publications of the Bureau of Entomology on wintering.

sufficiently protected during the winter and spring. The single-walled hive was first made as a means of reducing the cost. Such a hive is a good tool for the beekeeper but it is a poor home for the bees. When the 10-frame hive was found too large to be filled with bees in time for them to go into the supers as soon as the honey-flow opened, instead of protecting the hive the use of the 8-frame hive was commonly adopted. This hive is in rather general use throughout the United States, although fortunately it is now being replaced by the 10-frame hive in many localities. In order that the beekeeper may reduce his labor, it would be well to raise the standard of colony strength by providing better protection and more room for the bees. This will to a large degree eliminate the spring manipulations so often practiced, will get better crops, and will make European foulbrood a minor trouble of the apiary.

REMEDIAL MEASURES.

When strong colonies headed by vigorous queens of resistant stock are present, European foulbrood will usually make little if any headway, yet from time to time there may appear cases which require treatment. The shaking treatment used for American foulbrood[1] is often advocated for European foulbrood and is recommended by many inspectors of apiaries. It was recommended in previous publications of this department, but later observations show that other methods are more reliable. If colonies are given young Italian queens at the time of shaking, results will usually be good, but unless this is done shaking is of little or no value. Some beekeepers practice heavy feeding of either honey or sugar sirup when European foulbrood appears. This often gives good results, for it brings about the conditions which are advocated as preventive measures, although as applied it constitutes a remedial measure. The same amount of stores left with the colony the previous fall will usually do more good than heavy spring feeding as a means of disease control.

The remedial measures here described should be used only to remove the disease if it enters the apiary. Preventive measures should then be employed to avoid a recurrence of the disease.

(1) The dead larvæ are easily removed from the cells, and the remedial treatment serves to provide conditions such that these may be removed by the bees during a period when no new diseased material is appearing in the combs. Usually the queen is removed from the colony, and, since a queen whose colony becomes badly infected is rarely of any value, she is killed. In five or six days all queen cells are removed, so that the colony is hopelessly queenless. The workers do not clean out the diseased cells so rapidly unless they have a queen

[1] For a description of this treatment the reader is referred to Farmers' Bulletin 442, "The Treatment of Bee Diseases."

or a queen cell. As soon as the dead larvæ are removed, which may be easily determined by examinations, the colony is given a young vigorous Italian queen of resistant stock. If only a few diseased cells are observed and if the colony is fairly populous the queen may simply be caged and released later when the dead brood is removed.

The length of time necessary for the cleaning out of the dead larvæ varies with the strength of the colony, and for weak colonies it may be necessary to wait until all brood has emerged before giving a young queen.[1] This method should not be employed unless each colony has enough bees to sustain at least five combs full of brood. Some colonies seem to clean out dead brood more rapidly than others of the same strength. If the honey-flow comes early it will usually be possible to reduce the period of queenlessness to a few days. A beekeeper may use the time necessary for cleaning up as an indication of the strength of his colonies, for if he finds a long time needed he may be sure that his colonies, for some reason, are not as prosperous as they should be. If it is certain that there will be no honey-flow until midsummer or later it is not so necessary, from the standpoint of good beekeeping, to have all colonies strong so early in the year, but it is surely an exceptional locality where there is nothing for the bees to get in early summer.

Where the beekeeper is dependent on a late honey-flow it is often desirable to move the bees during the early part of the season to some place where nectar may be obtained. This will often be easier and less expensive than treating the colonies. For example, the author was shown a location in the west where European foulbrood caused great annoyance during the spring, while apiaries not many miles away were able to get enough nectar to ward off the disease and at the same time to give the beekeeper enough profit to justify the expense and time of moving. In such a case preventive measures are cheaper and better than the remedial measures here described. Apiary inspectors should exercise judgment in such cases and permit the moving of colonies to such places, provided they are sure that due precautions will be taken. No precautions need be demanded if the new location is already infected.

[1] This method of treatment was described in its essentials in 1905, in an article published in a periodical devoted to beekeeping. The writer of that article advised that the colony be left queenless for three days after all drone-brood has emerged, thus making a queenless period of 27 days. Later other beekeepers tried shorter periods with success. It should be remembered that the apiaries belonging to the writer of the article referred to were located in the buckwheat region of New York, and that he used a small hive, and on account of these conditions it may be safely assumed that at the time when European foulbrood attacks colonies his colonies were unusually weak. Those who have found a shorter time sufficient have been located in regions where the colony strength may be developed earlier because of earlier honey-flows, or perhaps in some cases these beekeepers wintered better, so that in the spring their colonies were in better condition to resist the ravages of the disease. It would be quite possible to refer to apiaries where the wintering is good and where the spring care is sufficient to eliminate entirely the period of queenlessness.

The methods of requeening and rearing the queens are matters aside from the treatment of European foulbrood, but in many cases the directions have been obscured by including all such details. Usually it is easier to introduce a queencell of the proper age for the queen to emerge and mate by the time egg laying may again proceed safely in the colony.

(2) A substitute for the treatment just described introduces no new principle. The colonies found to have European foulbrood are graded according to strength, and half or more of the stronger ones are shaken to dry extracting combs (not comb foundation) at the same time that the old queens are killed and replaced by young, vigorous stock. No colony too weak to have five frames of brood should be so treated. If there is no honey coming in, the combs may contain some honey, and it is immaterial whether or not it comes from a colony having European foulbrood. The removed brood is now stacked on the weaker diseased colonies so that they may be increased in strength. Just as soon as these have reached the degree of strength possessed by the first colonies shaken, they, too, may be shaken to drawn combs containing no brood, and the diseased brood is given to the remaining few diseased colonies. Usually by the time that the last colonies are ready for treatment it will be found that treatment is not necessary, for in many cases the dead brood will have been removed. If necessary, of course, every diseased colony may be treated.

This substitution for the more usual method of treatment has certain advantages. No colony is left queenless and, as a result, the total brood reared in the apiary is increased. No brood is wasted, and the colonies which receive the most of the combs containing diseased brood are usually made sufficiently strong to gather a good crop.

(3) Another method which is much used is to place all the brood combs of the infected colony except one in the second hive body over a queen-excluder and to place the queen below with the one frame of brood and frames containing foundation or even drawn combs. Others prefer to put the queen and one frame of brood above. Of course only good Italian queens should be used.

It is interesting to note that the methods used in the control of European foulbrood are exactly the same as are used in remedial methods for swarm control.[1] Either the queen or the brood is removed or the queen and brood are separated within the hive. Such a similarity is probably of significance, but this at present is merely a matter of speculation.

GOOD BEEKEEPING WILL ERADICATE THE DISEASE.

It can not be emphasized too strongly that the practices of good beekeeping are those which result in the eradication of European

[1] See Farmers' Bulletin 503, "Comb Honey."

foulbrood. It does not follow that because a beekeeper is troubled with European foulbrood he is a poor beekeeper, for he may have had good results before the disease appeared. With the entrance of the disease, however, he can change his system so as to overcome the trouble and he may do this with assurance that the changes are such as to result in good beekeeping. Unlike American foulbrood, the disease does not make it necessary that anything of value be destroyed by the beekeeper, and if the proper system of management for the particular locality can be found it will result, in most circumstances, in larger crops than are usually obtained.

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